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Distribution of Meteor Streams. By W. F. Denning.

I recently compiled a general catalogue of all the meteor streams recorded in the various publications which I collected together for the purpose. These include the observations or reductions of Backhouse, Bártfay, Corder, Denning, Denza, Greg, Gruber, Herschel, Heis, Kobold, Konkoly, Kövesligethy, Maggi, Neumayer, Sawyer, Schiaparelli, Schmidt, Serpieri, Tupman, Weiss, Zezioli, and many other minor contributors.

Mr. Greg's last Catalogue of 1876 was based on 850 radiants deduced from 15,000 catalogued meteors. At the present time we have 3,035 radiants, derived from more than 82,000 meteors. There has been an enormous increase in these observations during the last ten years.

Upon analysing all the positions, I find they exhibit a very unequal distribution amongst the constellations, a fact which is unquestionably due, partly to real differences, and, in a less degree, to the relatively excessive observations accumulated in certain months of the year. In Right Ascension the 3,035 radiant points are situated as follows:

R.A. °		°	Radiants.	Per-centage.	R.A. °		°	Radiants.	Per-centage.
1	to	30	378	12·4	181	to	210	147	4·8
31	,,	60	449	14·8	211	,,	240	186	6·1
61	,,	90	315	10·3	241	,,	270	217	7·2
91	,,	120	229	7·6	271	,,	300	254	8·4
121	,,	150	192	6·3	301	,,	330	243	8·0
151	,,	180	142	4·7	331	,,	0	283	9·3

The meteor streams cluster in greatest abundance between 1° and 60° of R.A. This is a fact irrespective of the cometary showers of Andromedes (Nov. 27) and Perseids (Aug. 10), which fall in this region, and might be supposed to have induced the singular condensation referred to. The zone, following it from 61° to 90°, shows a great decline, notwithstanding it includes the Orionids (Oct. 17–20), and the mass of showers originating in *Auriga*, *Camelopardus*, and the eastern quarter of *Taurus*. And the zone, 331° to 0° preceding the region of maximum, though rich in Aquariads, Pegasids, Lacertids, and Cepheids, exhibits a great deficiency as compared with it. The excess, so decided in character, between 1° and 60° is distinctly to be attributed to the Cassiopeïds, α, β, and γ Andromedes, Arietids, Muscids, α and β Perseids, Taurids, &c., which, combined with the cometary showers of Andromedes and Perseids, swell the aggregate number to an abnormal figure.

The minimum proportion of showers is clearly indicated

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between 151° and 210° R.A., which does not much exceed one-third of those grouped between 1° and 60°, the relative figures being 289 and 827.

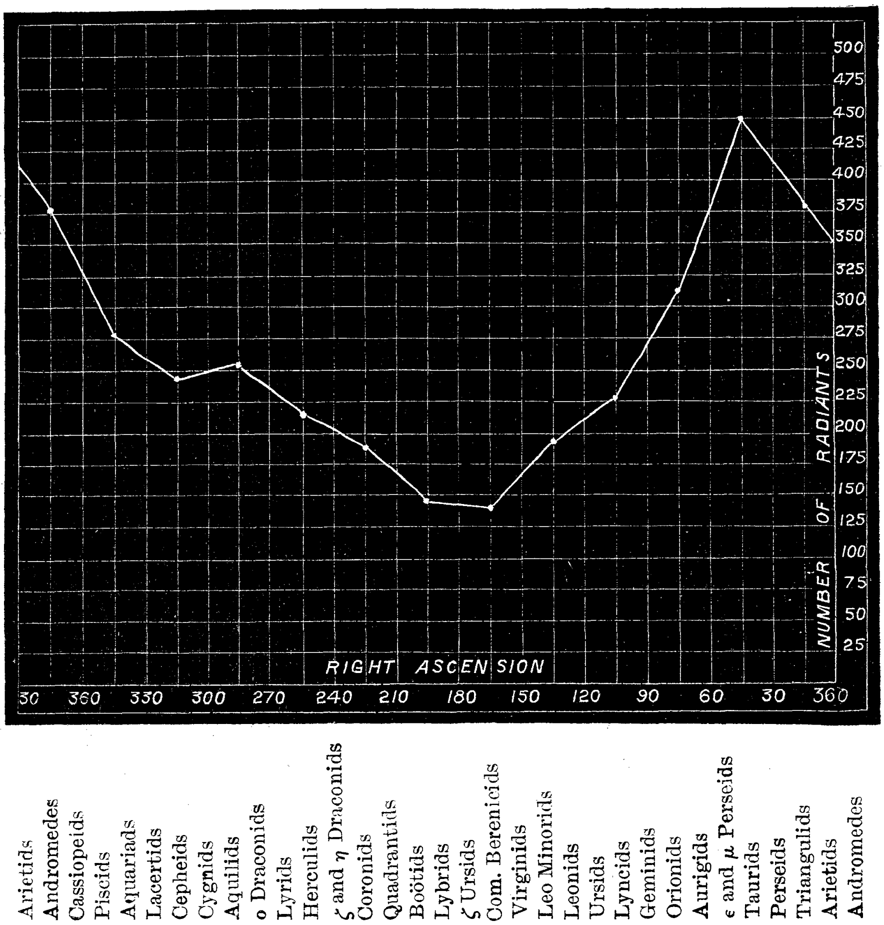

FIG. I.—Distribution of meteor streams in Right Ascension.

In North Polar Distance the showers are placed as follows:

N.P.D.			Radiants.	Per-centage.	N.P.D.			Radiants.	Per-centage.
°		°			°		°		
0	to	9	39	1·3	60	to	69	392	12·9
10	,,	19	141	4·7	70	,,	79	335	11·0
20	,,	29	243	8·0	80	,,	89	211	6·9
30	,,	39	473	15·6	90	,,	99	127	4·2
40	,,	49	489	16·1		+99		170	5·6
50	,,	59	415	13·7					

The maximum obviously lies between 30° and 49° N.P.D., and the minimum naturally occurs at the pole, inasmuch as the zone 0° to 9° includes a much smaller area than any other.

The distribution of the observed radiants in N.P.D. is

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affected by the differences in the areas of the several zones and their relative degrees of visibility. Though towards the pole the total space included in the zones becomes less, yet this is in a large measure compensated for by their more favourable position and the persistency with which they are displayed to view. The entire zones, from 0° to 49° N.P.D., never fall below the horizon, and such showers as they present are therefore determinable at any period of the year or time of night. This applies specially to English latitudes, but it also has a general reference (with perhaps slight modification in certain instances) because nearly all our existing observations of shooting stars have been made at stations having considerable (*i.e.* exceeding 35°) north latitude. The summary proves that while the two zones embraced between the parallels of 30° and 49° N.P.D. have the largest number of recorded streams, the three zones succeeding towards the equator exhibit a gradual decline, though each remains fairly prolific. The Andromedes, Perseids, and Quadrantids are arranged between 30° and 49°, while the Geminids, Leonids, and Lyrids, are clustered between 50° and 69° N.P.D. Considering all the circumstances, there do not appear to be great inequalities of grouping in North Polar Distance similar to those which undoubtedly occur in Right Ascension, but the point requires further investigation.

In considering the distribution of meteor streams, several important conditions must not be lost sight of. The bulk of the observations have been effected in the summer months, whence it necessarily follows that such constellations as are most favourably visible at this period must certainly appear to exhibit a predominance of showers. I gave a summary in the *Monthly Notices*, vol. xxxix. p. 411, showing the comparative monthly numbers of meteors registered in twelve catalogues, and I have now added several others, the aggregate including 82,156 meteors, with the following result:

Month.	Meteors Catalogued.	Percentage.	Month.	Meteors Catalogued.	Percentage.
January	2804	3·4	July	10670	12·1
February	1826	2·2	August	31516	38·1
March	1764	2·1	September	4304	5·1
April	5585	6·8	October	6840	8·3
May	2120	2·6	November	8319	11·3
June	2353	2·9	December	4055	4·9

These numbers are derived from the catalogues of Corder, Denning, Denza, Heis, Konkoly, Lucas, Sawyer, Schmidt, Tupman, Weiss, Zezioli, and the Italian Meteoric Association, 1869, 1870, and 1872, and some minor lists.

Now, more than one-half the total number of observations were obtained in July and August, and, in point of fact, are

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nearly all embraced between the period from July 20 to August 15. The majority of the observations have been secured before midnight, and it is therefore certain that the region of 31° to 60° R.A., which is for the most part either below the horizon or low in the north-east at the special epoch when the largest number of meteors have been recorded, is not rendered rich solely by the abundance of observations. Indeed the months of September, October, and November appear to have furnished, relatively to the number of meteors catalogued, by far the greatest number of showers in this quarter of the sky. I believe, therefore, the great superabundance of streams about *Andromeda*, *Aries*, and *Perseus* is a real one.

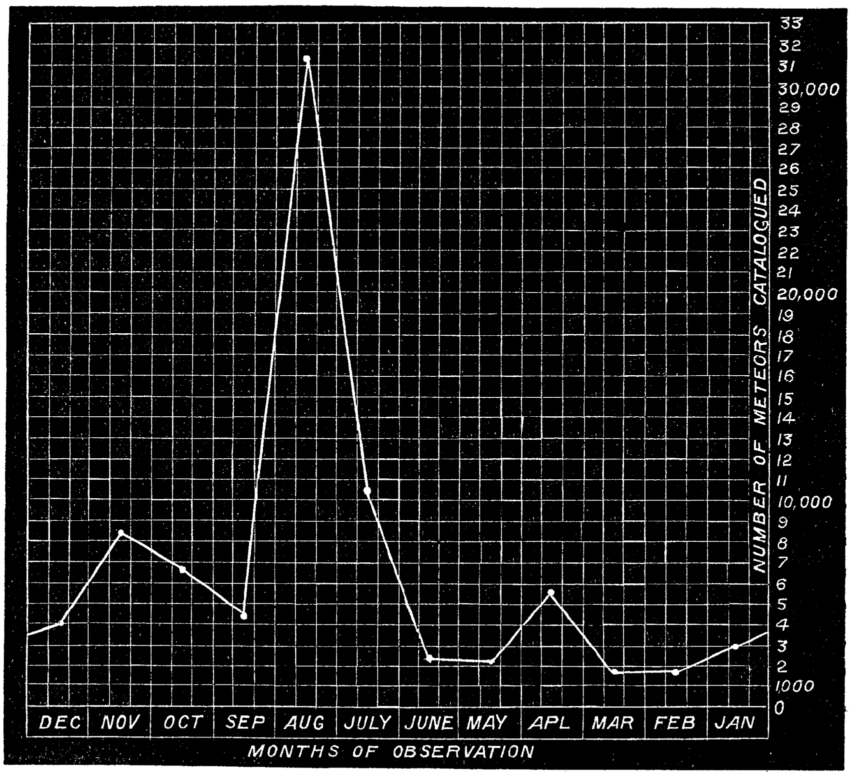

Fig. II.—Relative numbers of meteors catalogued during the twelve months.

We must remember that the large proportion of meteors catalogued in July, August, and later months is far from being entirely due to the more extensive watches undertaken at those times. It is attributable in a great measure to a real surplus in the visible number of meteors. All regular workers in this department agree as to the far greater frequency of meteors during the last half of the year as compared with the first half. From my own observations, up to the end of 1885, comprising 7,100 meteors, I find that the average horary number for one observer from January to June is 6·95, and from July to

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December 12·65, so that the excess in favour of the last half of the year is nearly in the proportion of 2 to 1. From this we may conclude that both meteors and meteoric radiants display by far the greatest profusion between July and December, and that the densest region of radiation lies between 1° and 60° of R.A. This is indeed the most active part of the heavens even as late as November, when it is some 110° distant from the apex of the Earth's way.

The known meteor streams, considered in respect to their apparent distribution upon the celestial vault, exhibit special regions of density and scarcity, not exactly regulated by the direction of the Earth's motion. The maximum number of showers is rarely seen in that part of the firmament towards which the Earth is directed, though with a perfectly equal distribution of streams this would be expected. The richest showers usually come from positions far to the west of the Earth's apex, and this is sufficient evidence that they exhibit a special construction or grouping together. The Earth becomes alternately involved with rich and tenuous regions at intervals of about six months.

Bristol: 1886, *November* 9.

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Ephemeris for Physical Observations

Greenwich Noon.	Angle of Position of ♃'s Axis. P	Latitude of Earth above ♃'s Equator B	Latitude of Sun above ♃'s Equator *B*	Annual Parallax. A−L.	L−O.	Longitude of ♃'s Central Meridian. (878°·25) I	Longitude of ♃'s Central Meridian. (870°·27) II	Corr. for Phase.
1886								
Dec. 9	22°·064	−2°·862	−2°·796	−7°·799	73°·435	34°·15	251°·43	+0°·264
14	21·877	2·893	2·804	8·282	74·297	104·86	282·24	·298
19	21·694	2·923	2·813	8·726	75·119	175·62	313·10	·331
24	21·516	2·952	2·821	9·127	75·898	246·45	344·02	·362
29	21·345	2·980	2·829	9·481	76·630	317·34	15·00	·390
1887								
Jan. 3	21·182	−3·008	−2·836	−9·784	77·311	28·29	46·05	+0·415
8	21·030	3·036	2·844	10·032	77·937	99·30	77·16	·437
13	20·890	3·063	2·852	10·222	78·505	170·38	108·34	·444
18	20·763	3·089	2·859	10·351	79·012	241·53	139·59	·465
23	20·651	3·114	2·866	10·414	79·454	312·75	170·90	·471
28	20·555	3·139	2·874	10·409	79·827	24·04	202·28	·470
Feb. 2	20·476	3·162	−2·881	−10·332	80·128	95·40	233·73	+0·463
7	20·416	3·185	2·888	10·181	80·356	166·83	265·26	·450
12	20·376	3·206	2·894	9·954	80·508	238·32	296·85	·430
17	20·355	3·225	2·901	9·649	80·582	309·88	328·51	·404
22	20·355	3·242	2·908	9·265	80·577	21·51	0·23	·372
27	20·375	3·258	2·914	8·802	80·492	93·20	32·02	·336
Mar. 4	20·416	−3·271	−2·920	−8·261	80·329	164·95	63·86	+0·296
9	20·476	3·282	2·927	7·644	80·092	236·75	95·76	·254
14	20·554	3·290	2·933	6·954	79·782	308·60	127·71	·210
19	20·650	3·295	2·939	6·196	79·403	20·49	159·70	·167
24	20·761	3·297	2·944	5·375	78·961	92·41	191·72	·126
29	20·884	3·296	2·950	4·497	78·462	164·35	223·76	·088
Apr. 3	21·017	−3·292	−2·956	−3·571	77·915	236·31	255·82	+0·056
8	21·158	3·285	2·961	2·607	77·330	308·28	287·88	·030
13	21·303	3·274	2·966	1·614	76·716	20·23	319·93	·011
18	21·451	3·260	2·971	−0·602	76·084	92·16	351·97	+0·002
23	21·598	3·243	2·976	+0·418	75·444	164·07	23·97	−0·001
28	21·741	3·223	2·981	1·434	74·808	235·93	55·93	·009
May 3	21·879	−3·201	−2·986	+2·434	74·188	307·74	87·84	−0·026
8	22·009	3·177	2·991	3·408	73·594	19·48	119·68	·051
13	22·129	3·151	2·995	4·347	73·035	91·15	151·46	·082
18	22·238	3·124	3·000	5·242	72·520	162·74	183·16	·119
23	22·335	3·096	3·004	6·085	72·058	234·25	214·77	·161